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ESA GlobSnow and EUMETSAT H-SAF: Climate Data Records and NRT Services on SWE

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ESA GlobSnow

• ESA-funded GlobSnow project: Production of novel global snow extent (SE) and snow water equivalent (SWE) climate data records.

• **Generation of long time-series empoying FMI supercomputing facilities at Helsinki** (daily, weekly and monthly maps of SE and SWE for northern hemisphere)

• **Near-real-time GlobSnow processing system and data archives located in Sodankylä**.

• Consortium members: Finnish Meteorological Institute (FMI) with ENVEO IT GmbH (Austria), GAMMA Remote Sensing (Switzerland), Norwegian Computing Center, Finnish Environment Institute (SYKE), and Environment Canada (EC).

• Details and products available at **www.globsnow.info**

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New Sodankylä GlobSnow Processing Facility

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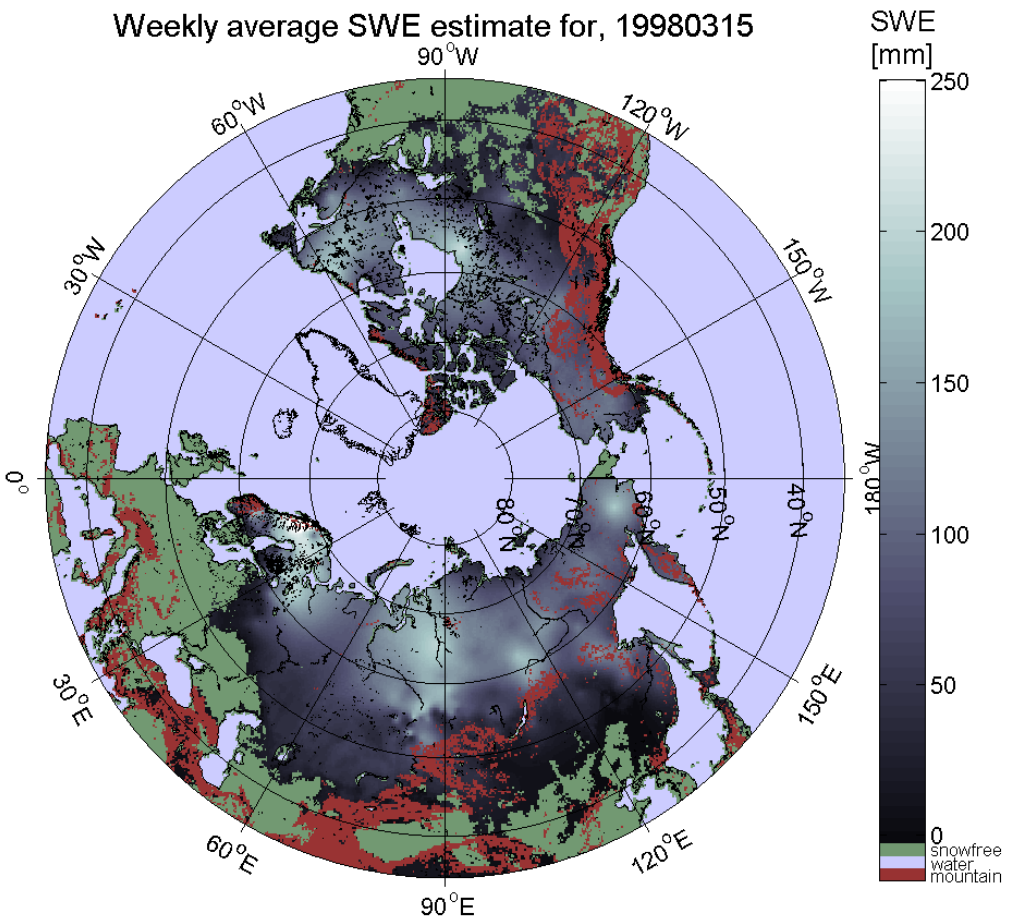
30 year-long CDR time-series on snow conditions of Northern Hemisphere (ESA-Glo

- First time reliable daily spatial information on snow cover:
  - Snow Water Equivalent (SWE)
  - Snow Extent and melt
  - 25 km resolution (EaseGrid)
- Passive microwave radiometer data combined with ground-based synoptic snow observations
  - Variational data-assimilation
- Available at open data archive (www.globsnow.info)
  - 30-year-long time-series (1979-2010)
- Demonstration of real-time hemispehiric processing started on October 2010 => implementtation with higher resolution in EUMETSAT H-SAF



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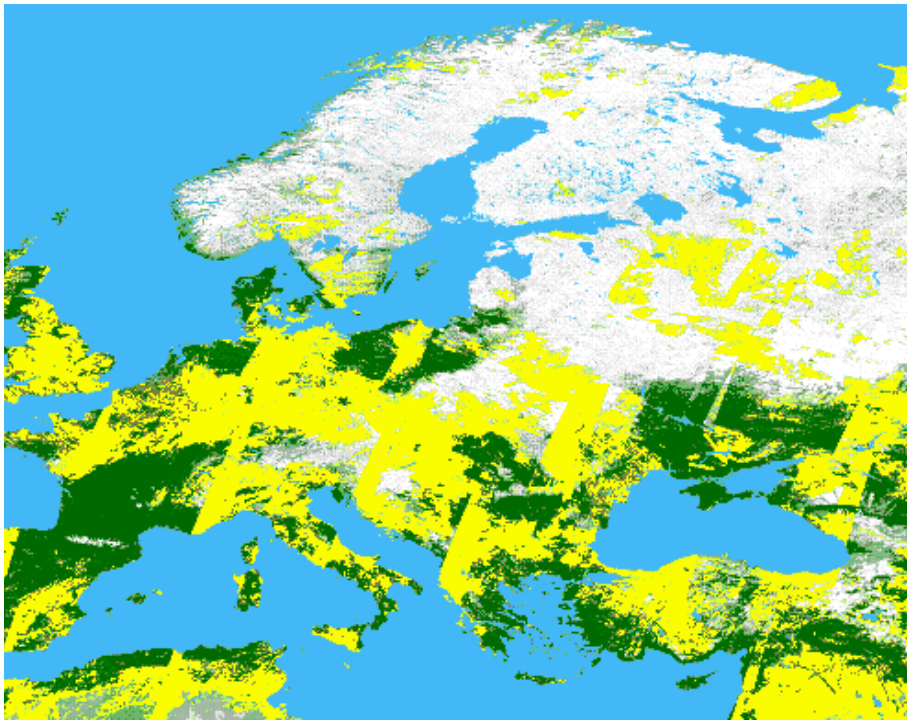
GlobSnow SE Dataset

- SE retrieval using ERS-2 ATSR-2 and Envisat AATSR data

- Norwegian Linear Reflectance' (NLR) fractional snow cover (FSC) algorithm;

- Finnish Environment Institute's SCAmod algorithm.

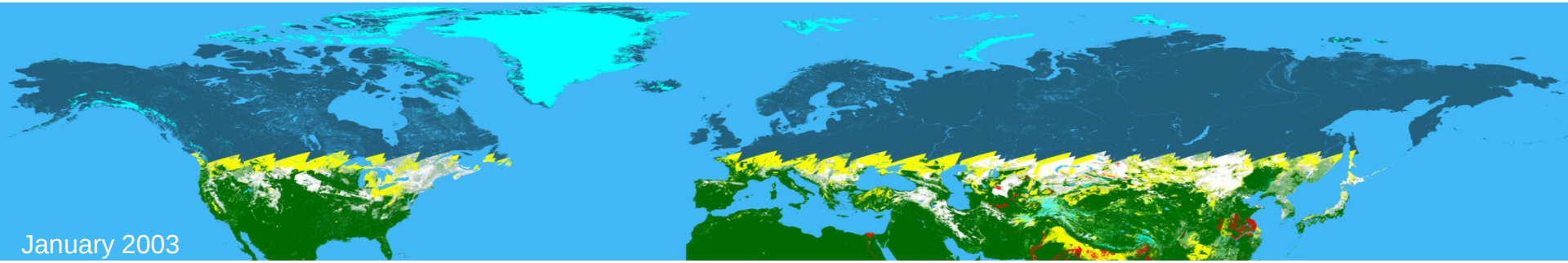
- Final data record spanning 15 years will be produced using optical imagery from ATSR-2 (1995-) and AATSR (2002-) on a global scale.

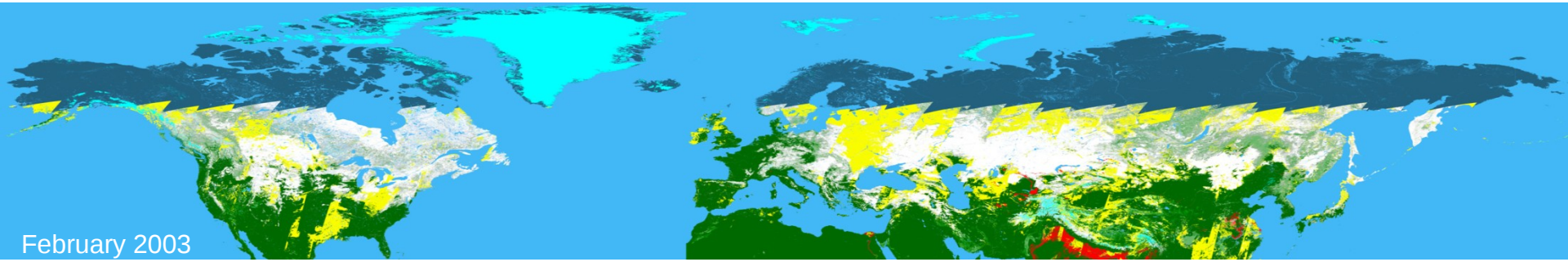


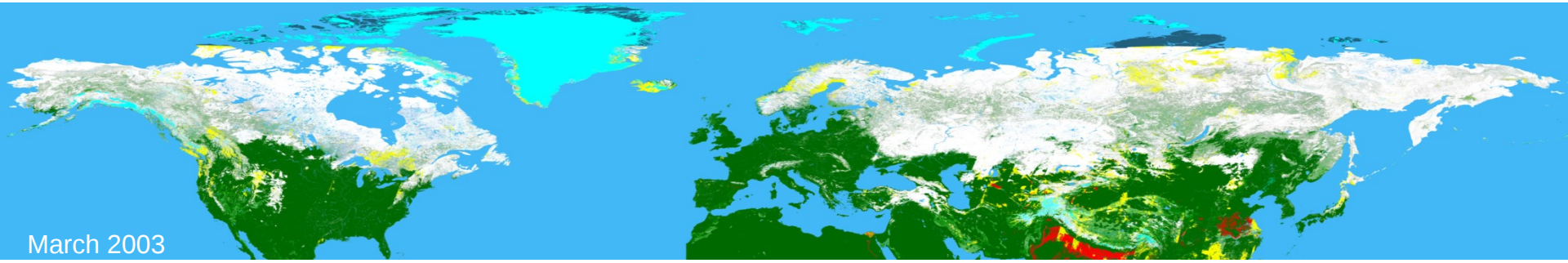
yellow – clouds
green – bare ground
white – snow cover

esa enveo GAMMA REMOTE SENSING NR Norsk Regnesentral SYKE Environment Canada Environnement Canada

Monthly products - Northern Hemisphere



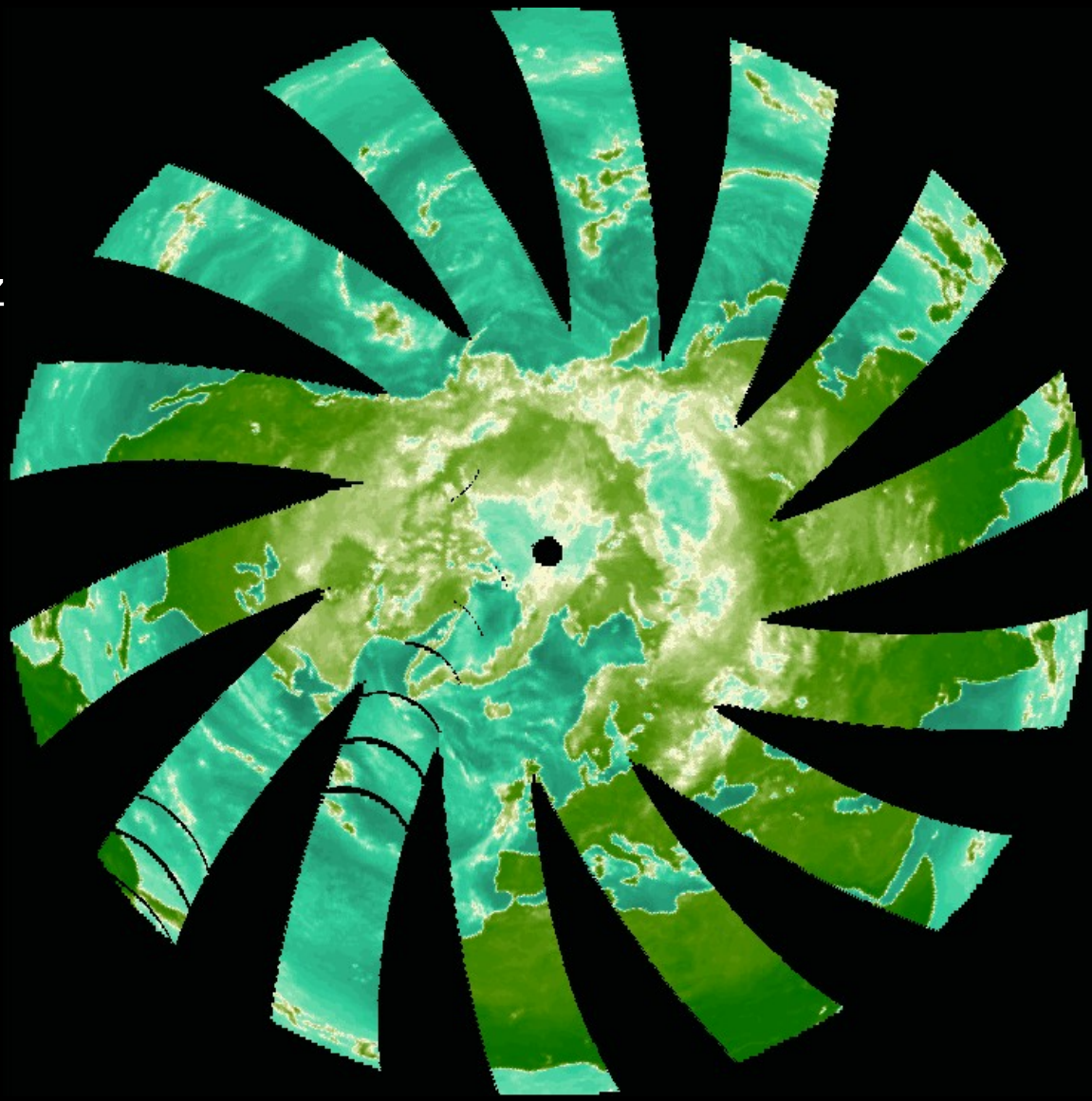




Principle of SWE algorithm

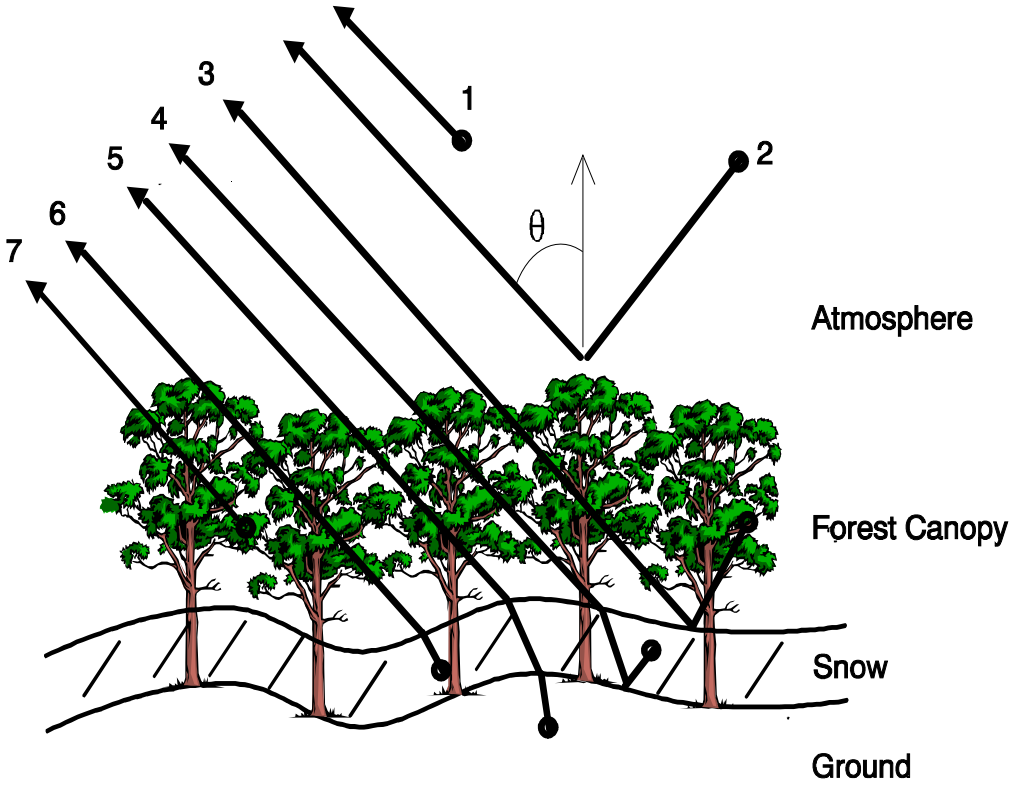
- **Weather station snow depth data is obtained from European Centre for Medium-range Weather Forecasts (ECMWF) and kriging interpolated over the area in question -> SWE estimate & SWE Var estimate**
- **Spaceborne radiometer data is obtained from National Snow and Ice Data Center (NSIDC). Data is either SMMR, SSM/I or AMSR-E.**
- **Snow grain size (and variance) is estimated using SD data and HUT Snow model for SD station locations. Values are interpolated over area under investigation.**
- **From spaceborne data estimates of the SWE are obtained using inversion of HUT model.**

Ascending node SSM/I microwave radiometer observations of the northern hemisphere from a single winter day, 1.1. 1999 (37 GHz horizontal polarization)

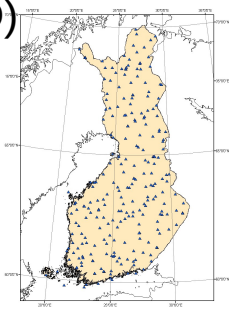


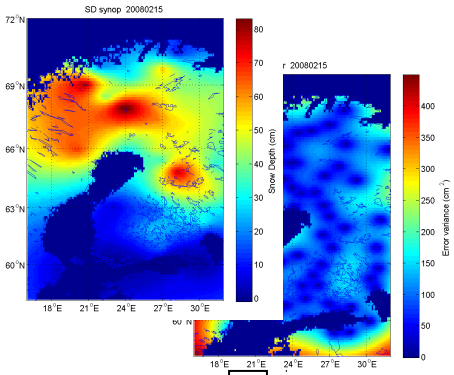
HUT snow emission model

- Background of the applied model
  - Semi-empirical model simple enough to be used for parameter retrieval from space-borne or airborne data (e.g. by statistical inversion)
- Basic characteristics
  - scalar radiative transfer model for single snow layer
  - semi-empirical formulas for snow permittivity and extinction coefficient
  - empirical coefficient for radiation contribution scattered in snow layer
  - incoherent approach used for medium boundary effects
  - soil-snow reflectivity by empirical soil emission models
  - empirical formulas for atmospheric and forest cover effect



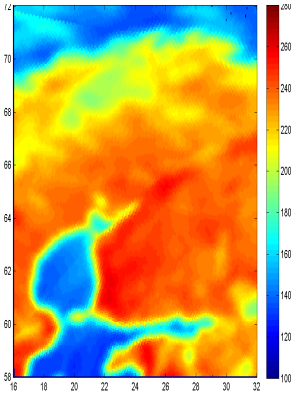
(2) Weather station obs. (SD)



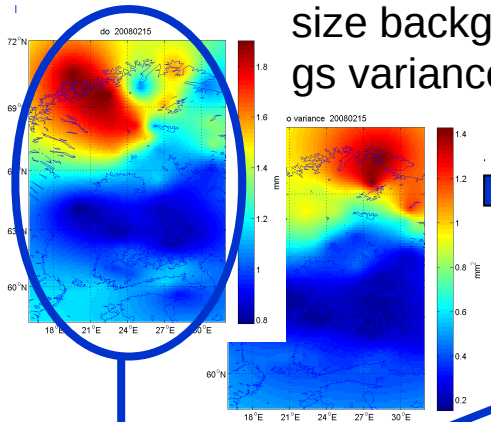


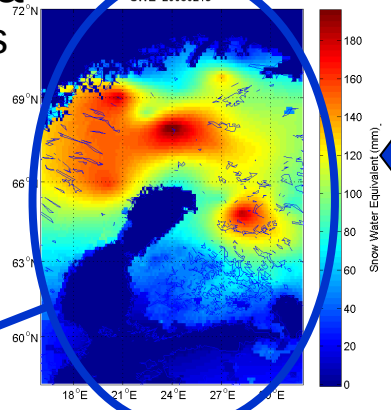
(4) Kriged SD & SD variance maps

(1) Satellite observation

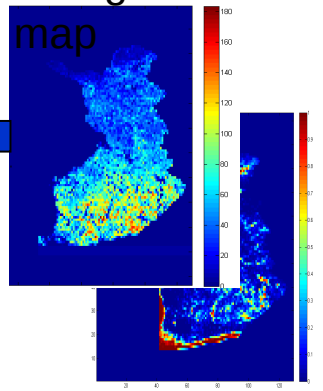


(3) Kriged grain size background & gs variance maps





(5) Vegetation background map

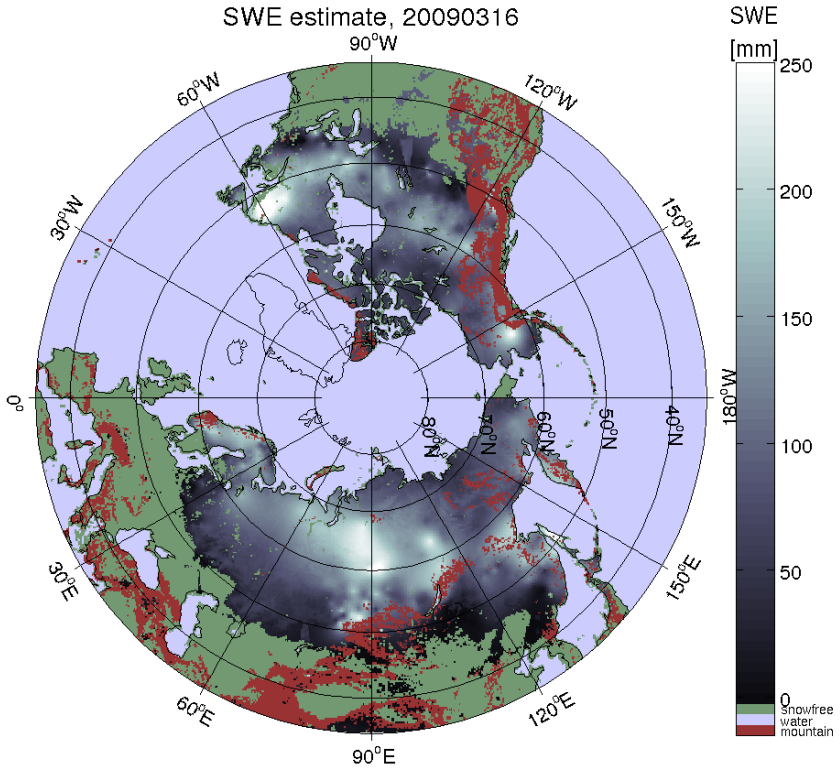


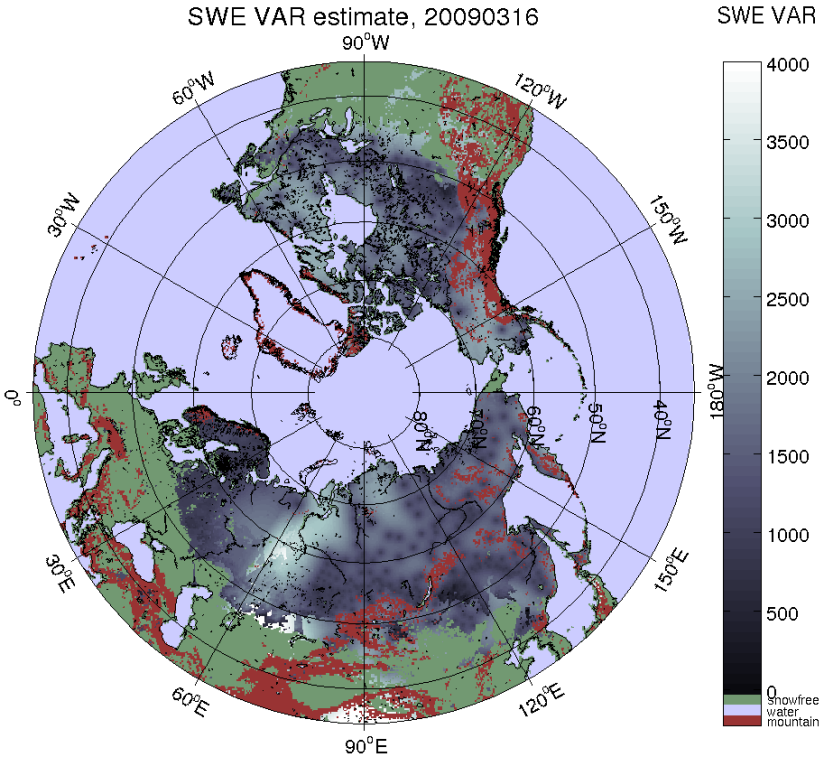
SD/SWE

HUT emission model applied

(6) Other data (e.g. lake fraction)

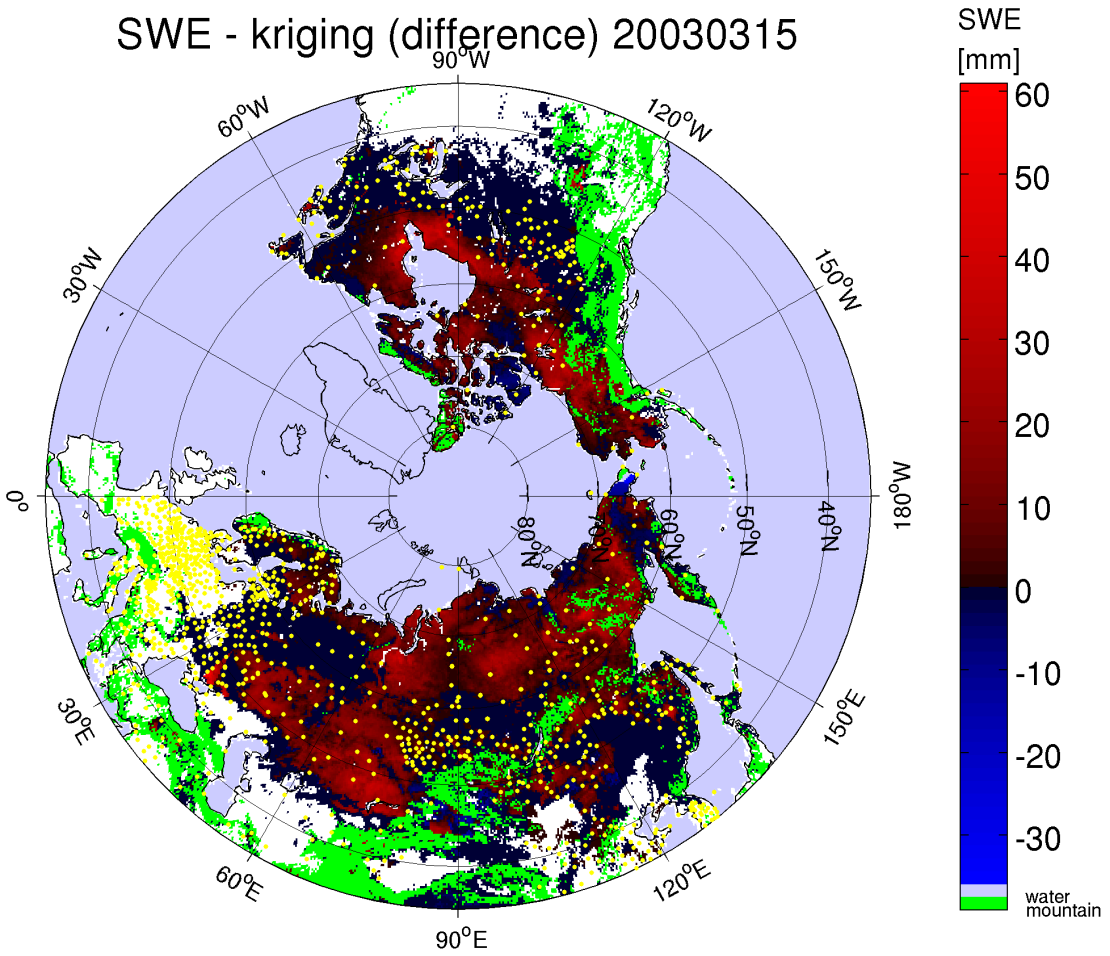
Example of SWE product





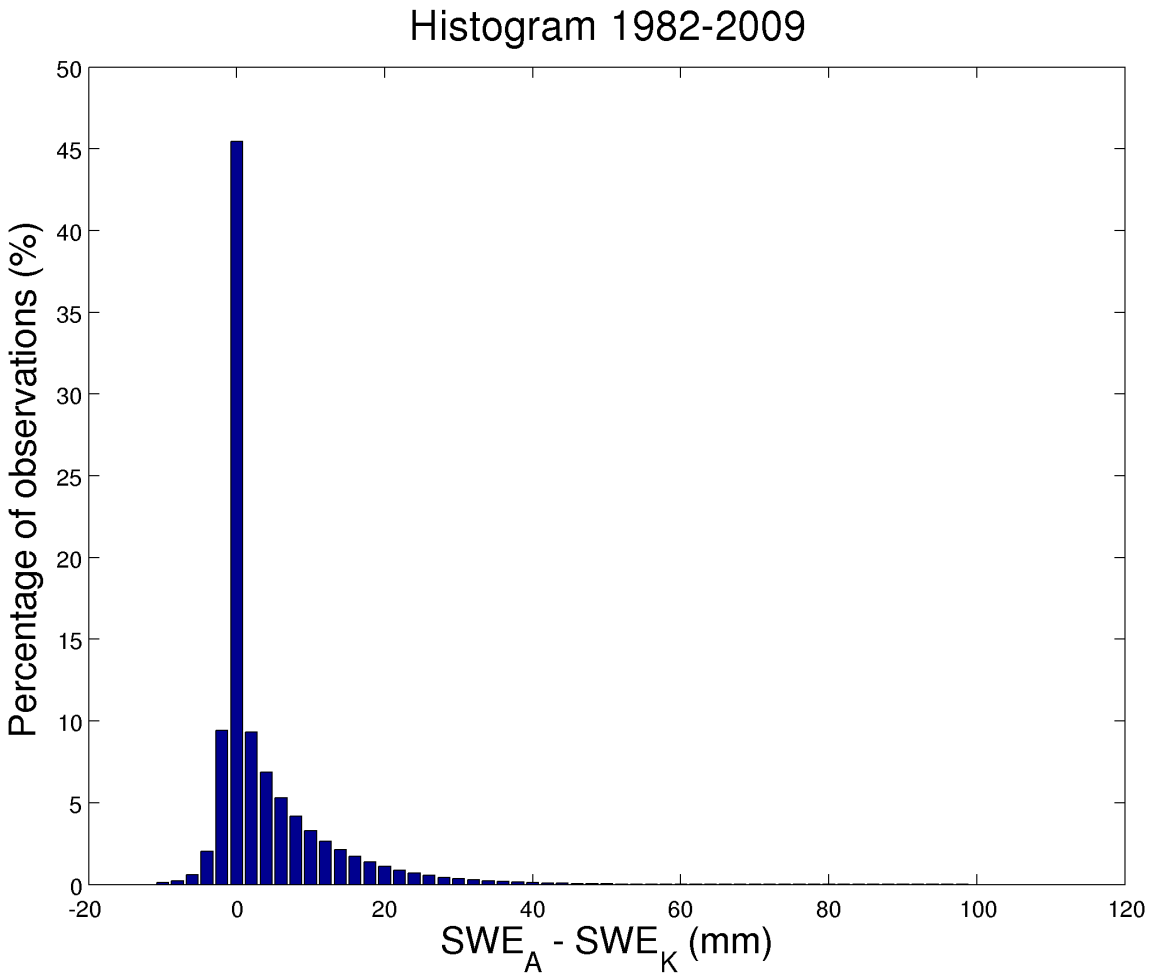
SWE algorithm assesment I

- **Difference between assimilated SWE estimate and kriging interpolation only fields**
- **Weather stations marked in yellow**

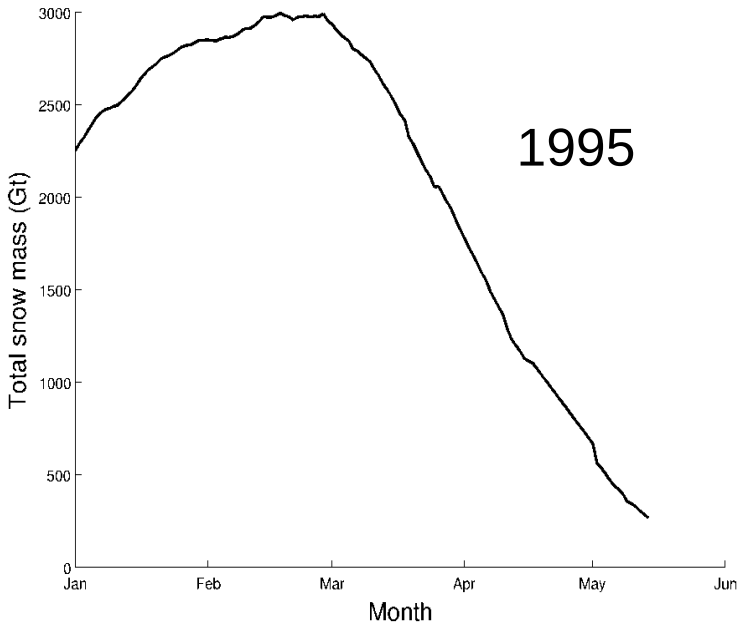


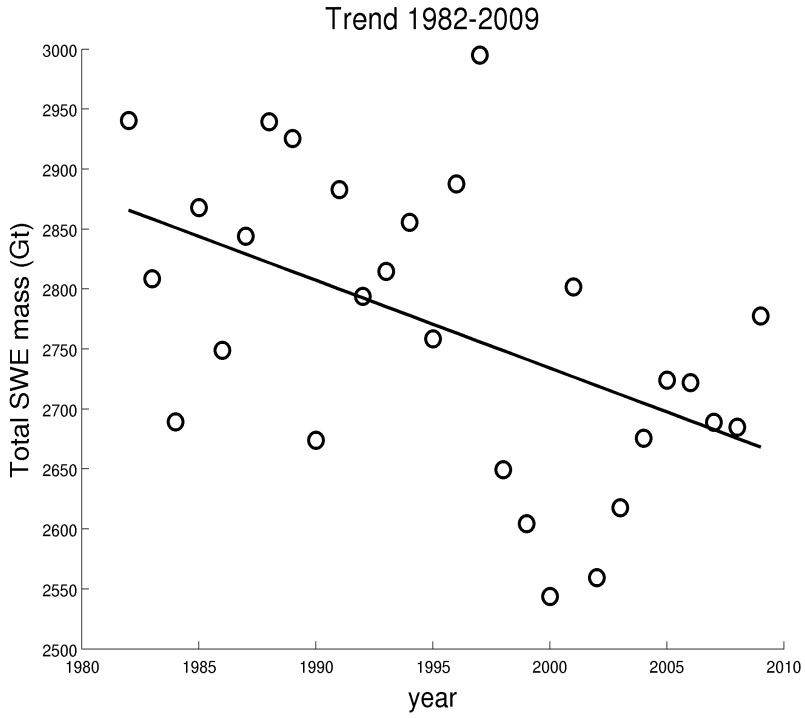
SWE algorithm assesment II

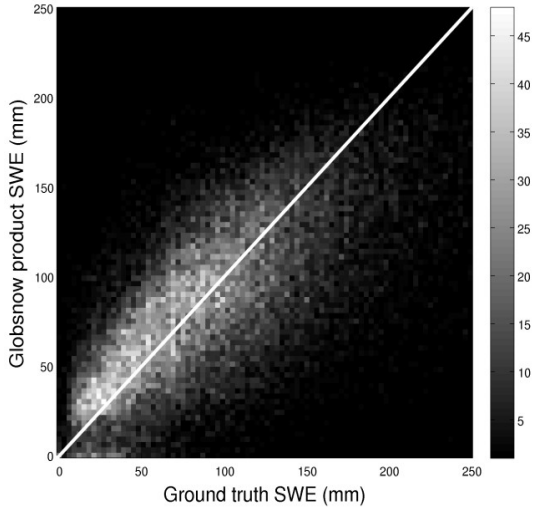
- **Histogram of difference between assimilated SWE result and kriging interpolated background field**
- **Typically increases accuracy in areas with sparse SD data**



Seasonal behaviour and hemispherical trend of snow mass

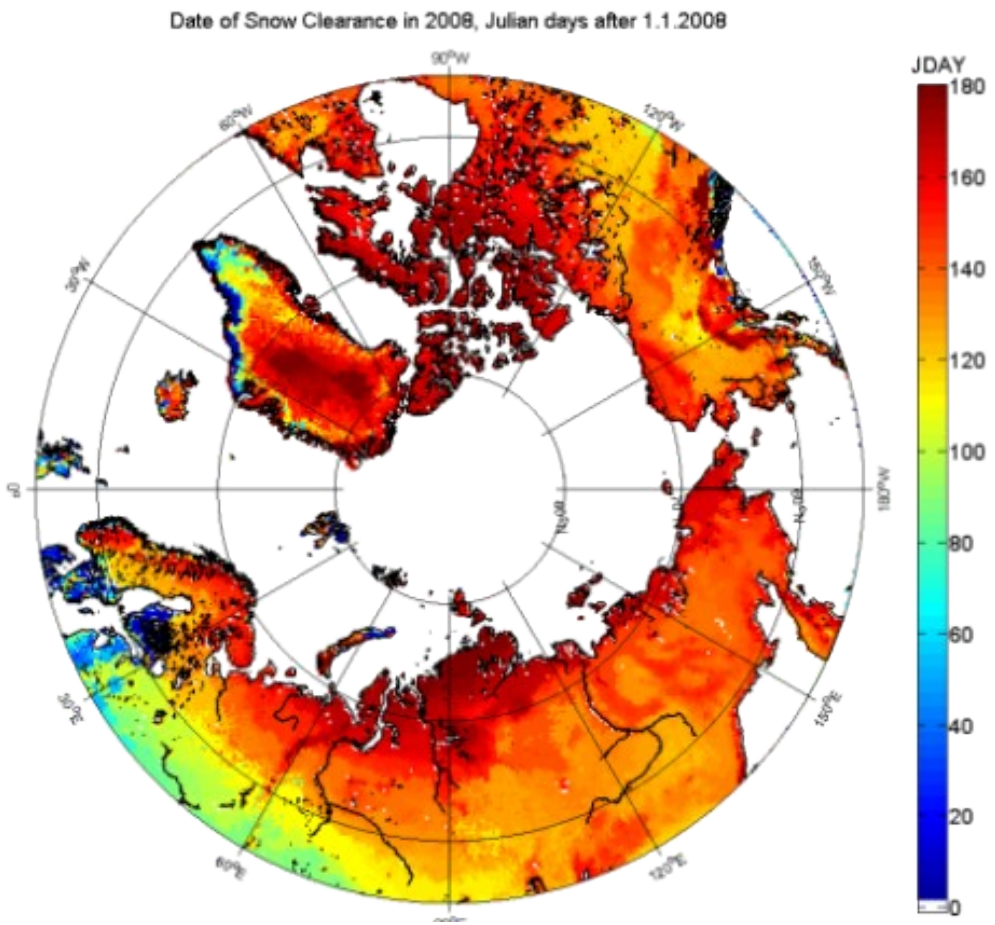






Snow clearance

- **Example for year 2008**
- **Time series of 30 years processed**



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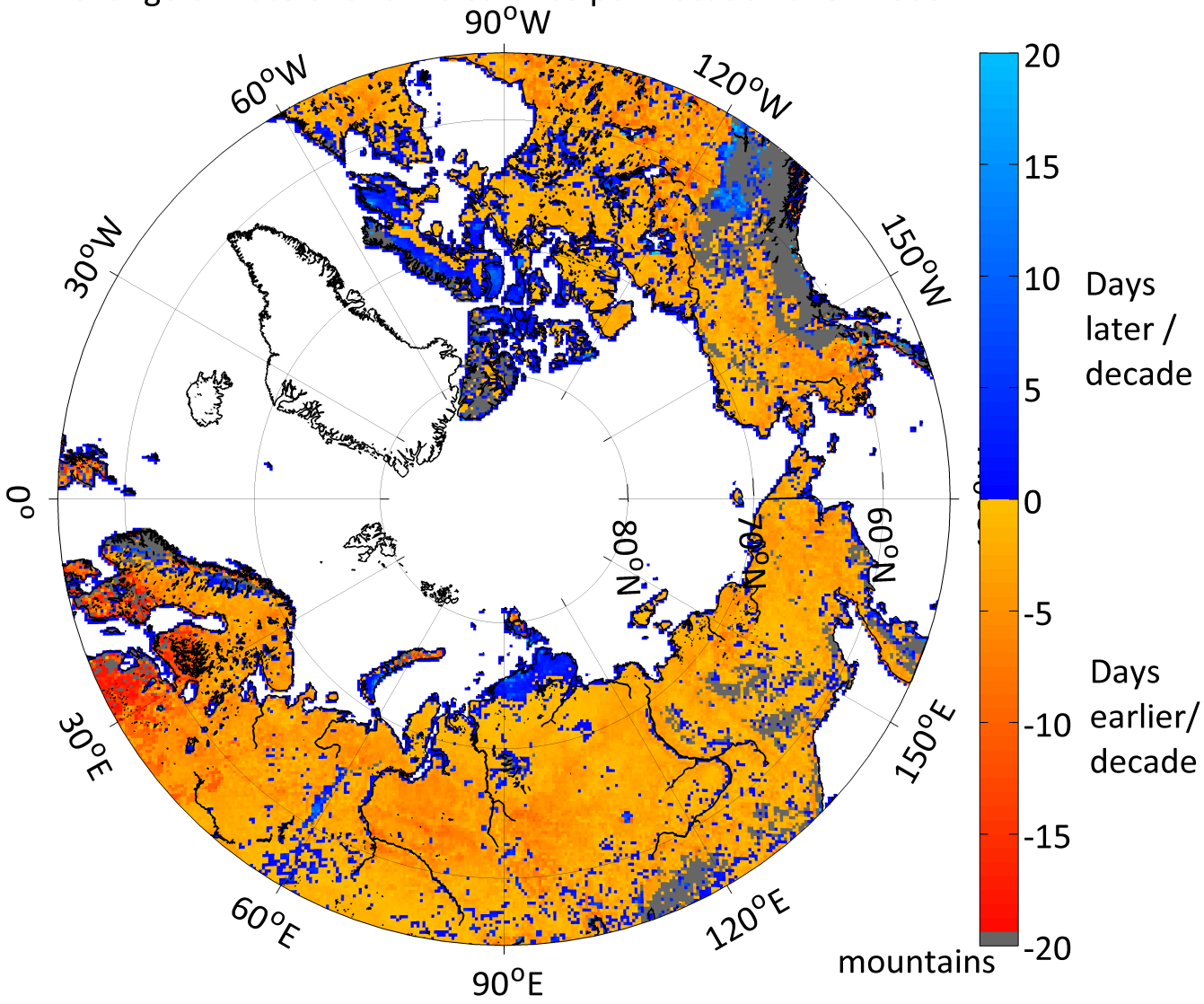
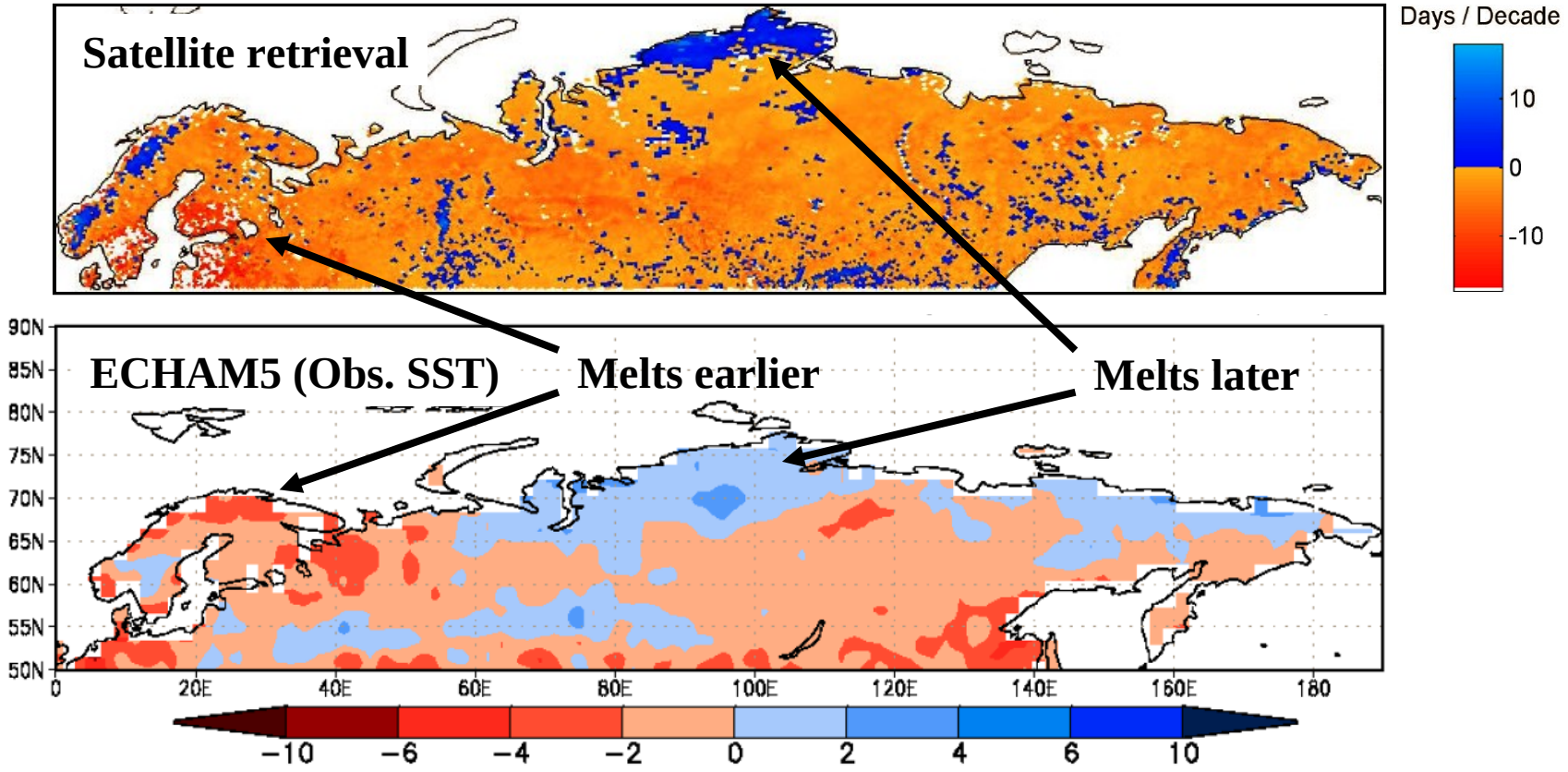
Change of Date of Snow Clearance per Decade 1978 - 2008



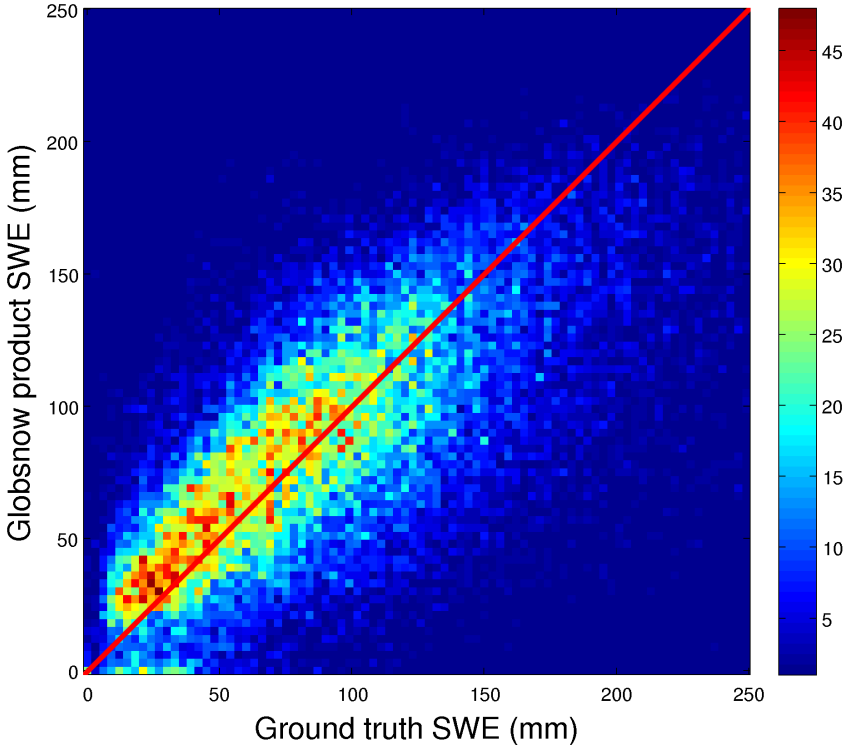
Trend in the snow melt date based on GlobSnow 30-year SWE product **(change in days/decade)**

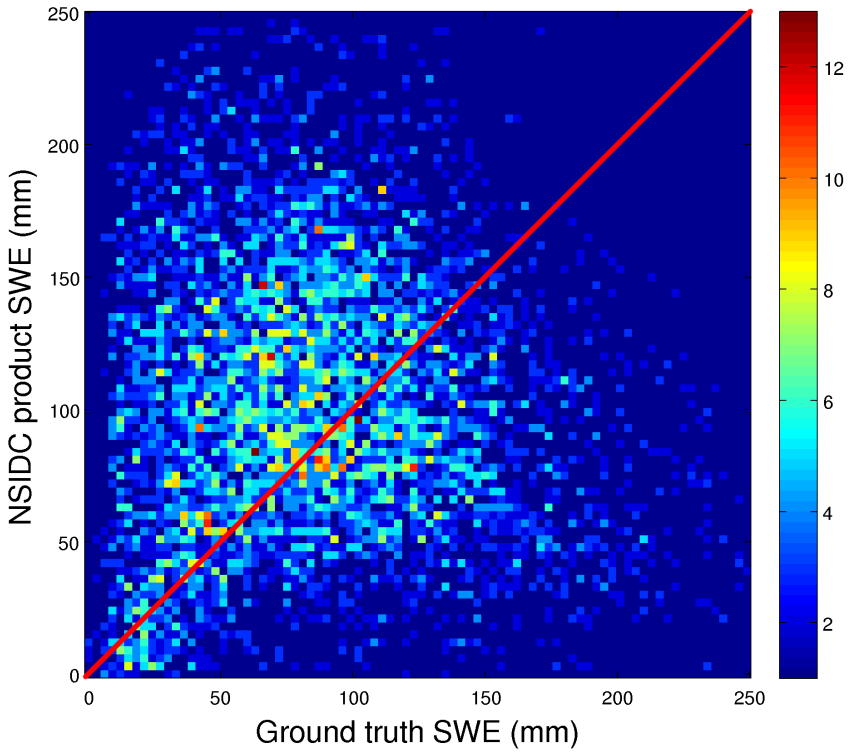


Conclusion: Confidence on the climate model's ability to represent Eurasian snow cover with reasonable accuracy

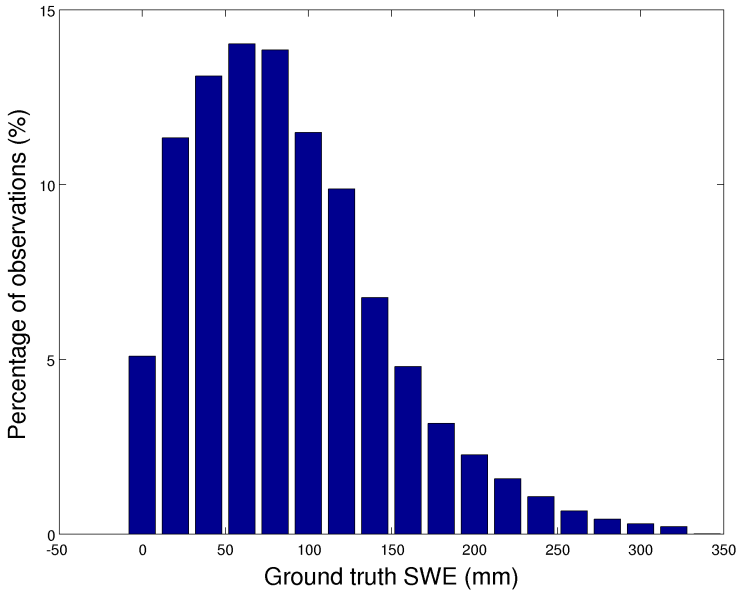
SWE retrieval accuracy (I)

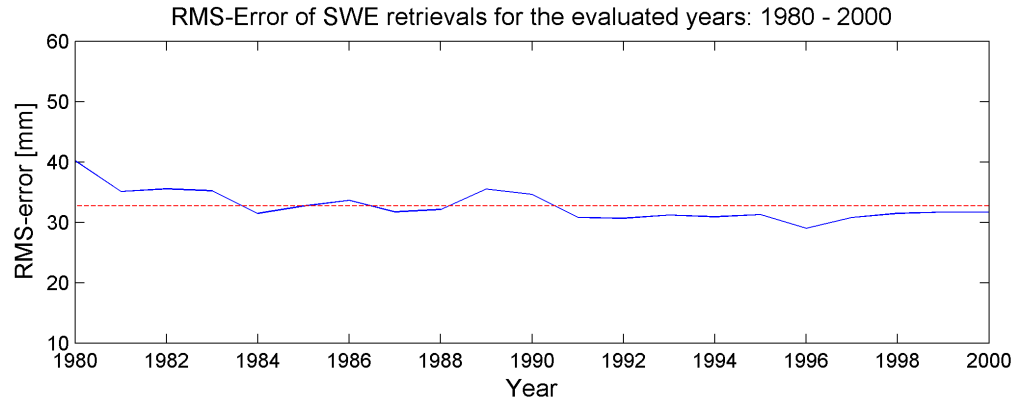
- **Density scatterplot**
- **Ground truth data is INTAS SCCONE SWE path data**

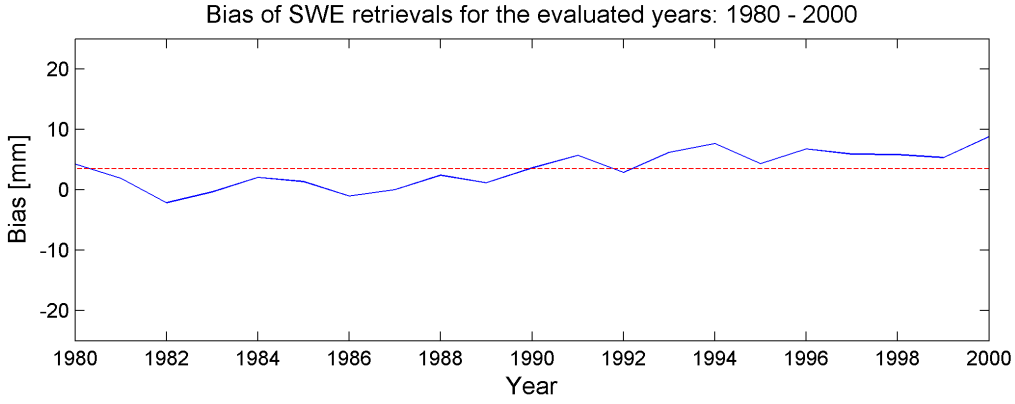




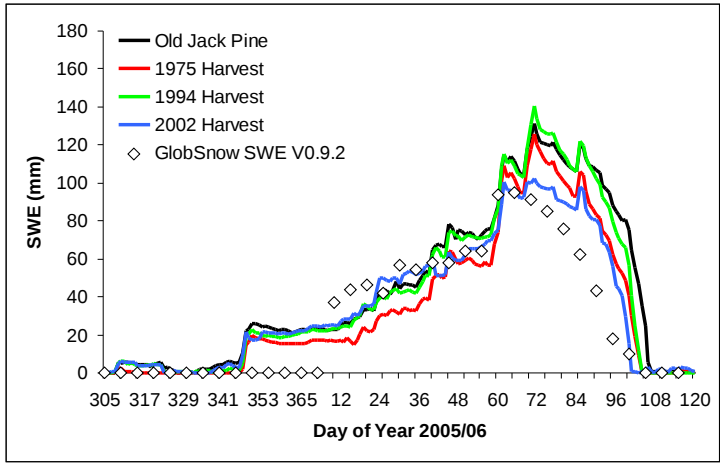
SWE retrieval accuracy (II)

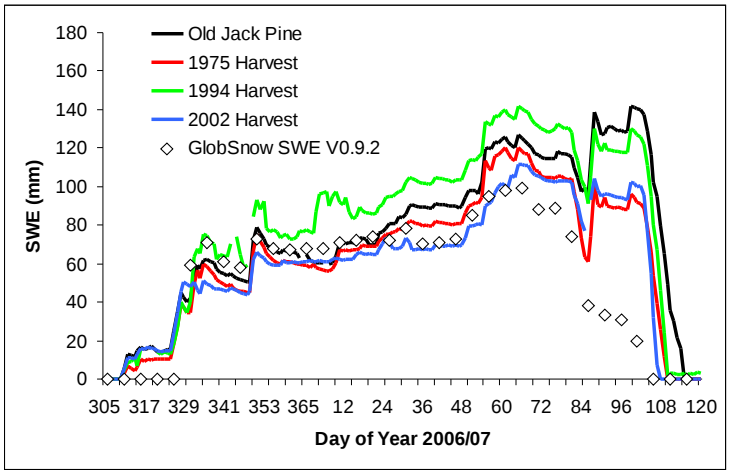


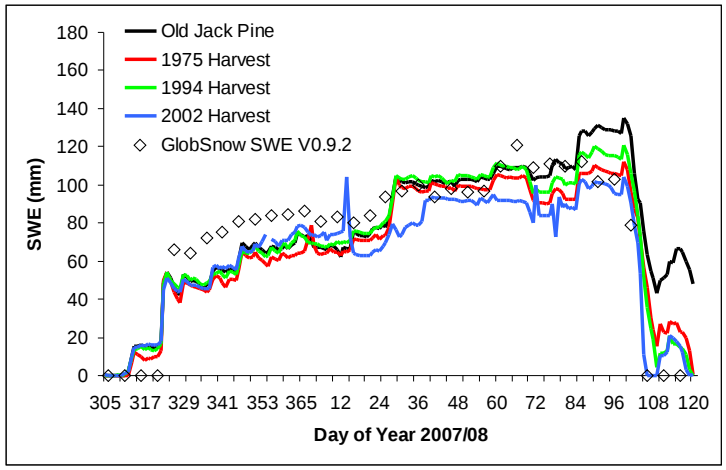


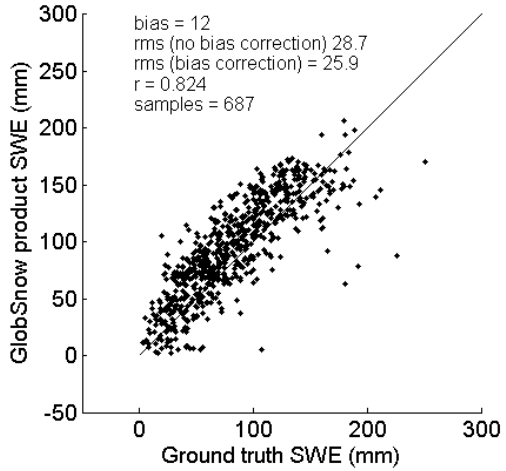


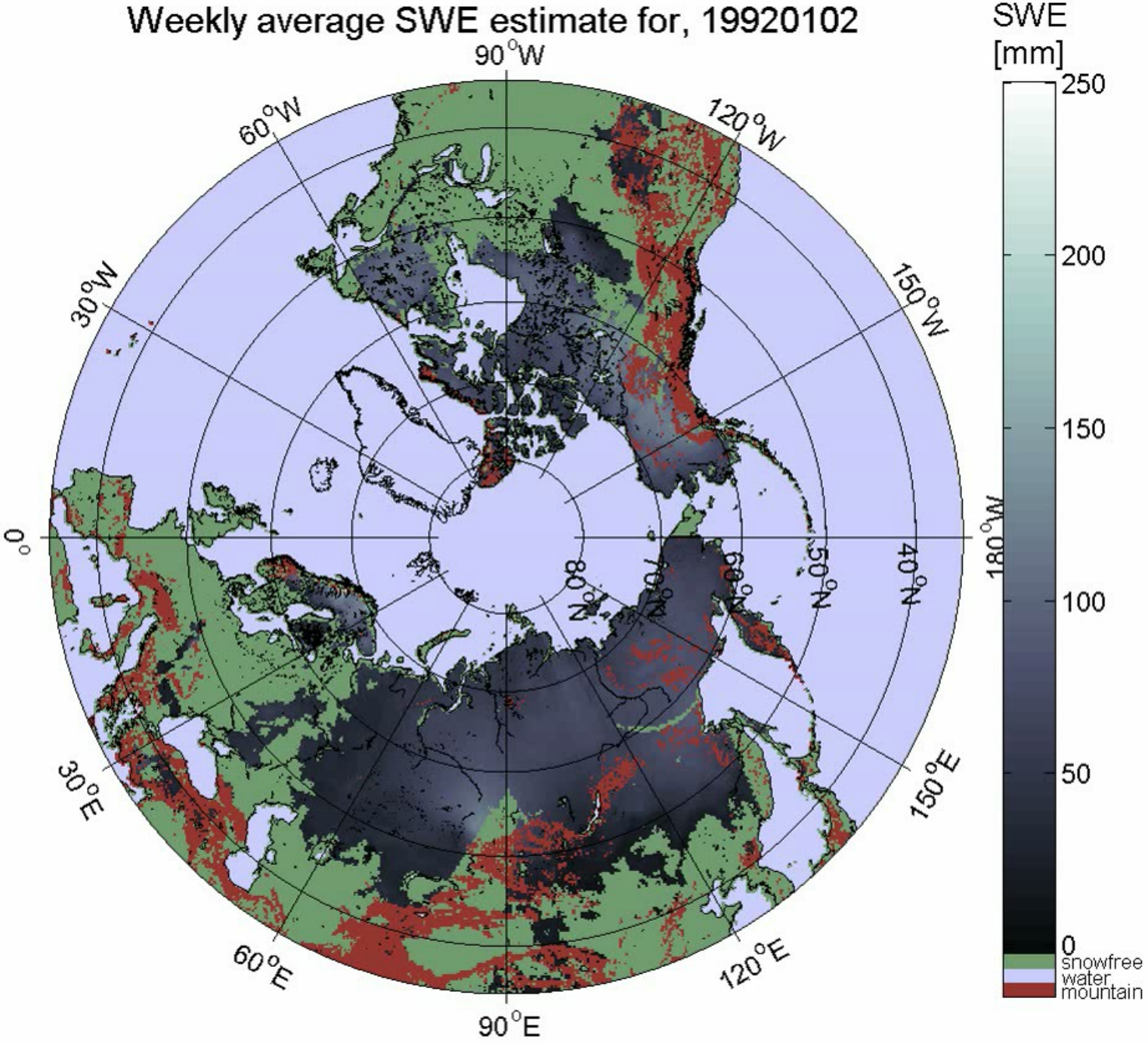
SWE retrieval accuracy III










Weekly average SWE estimate for, 19920102
SWE
[mm]
250
200
150
100
50
0
snowfree
water
mountain
90°W
60°W
120°W
30°W
150°W
0°
180°W
30°E
60°E
120°E
150°E
90°E
80°N
70°N
60°N
50°N
40°N

Generation of SWE indices from GlobSnow Products

- **GlobSnow products enable the generation of information on SWE of drainage basins (alpine areas excluded at the moment)**
  - SWE climatalogy for a given drainage basin based on 30-year-long daily time-series
  - NRT product can be used to generate SWE values for a given drainage basin (e.g. maximum level prior to on-set of melt)

  ⇒ Comparison of real-time value with climatology can be potentially used as index for hydrological evaluations

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GlobSnow - Summary

Production of novel global **snow extent (SE)** and **snow water equivalent (SWE)** climate data records (15 and 30 years of snow cover information)

- Version 1.0 for SWE and SE are available
- Version 1.1 by autumn 2011

Additionally, near-real-time GlobSnow processing demonstration is ongoing with open data access (started December 2010; improved version for winter 2011 - 2012)

Details and products available at **www.globsnow.info**

Thank You for Your Attention!